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SAR data based Landmark Navigation for highly precise Vehicle Localization

HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFTEN MÜNCHEN

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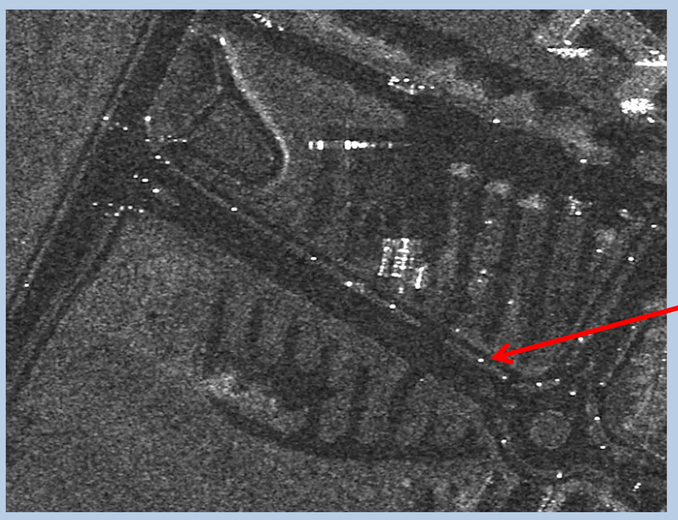
Motivation

- **GPS** not constantly reliable in **urban areas** (shading, disturbance, etc.)
- Static urban objects (**streetlamps**, **traffic light posts**) are detected in radar images and function as precise **Landmarks** in georeferenced map (Project "**DriveMark®**")
- Development of additional and **redundant positioning solution** related to GPS: Detection of Landmarks with low-cost **LiDAR** and estimation of **ego position** within precise map

❶ High precision landmark map

- DriveMark® provides **Ground Control Points (GCPs)** via remote sensing data with an **accuracy within the cm level**
- Generated out of satellite **Synthetic Aperture Radar** (**SAR**) data by SAR Geodesy Processor
- GCPs are specific objects at the **roadside** (lamp poles, traffic lights, traffic signs)



TerraSAR-X image of test region

❷ Mobile experimental platform

Landmark detection

Low-cost **LiDAR Sensor (Hokuyo UTM-30LX-EW)**

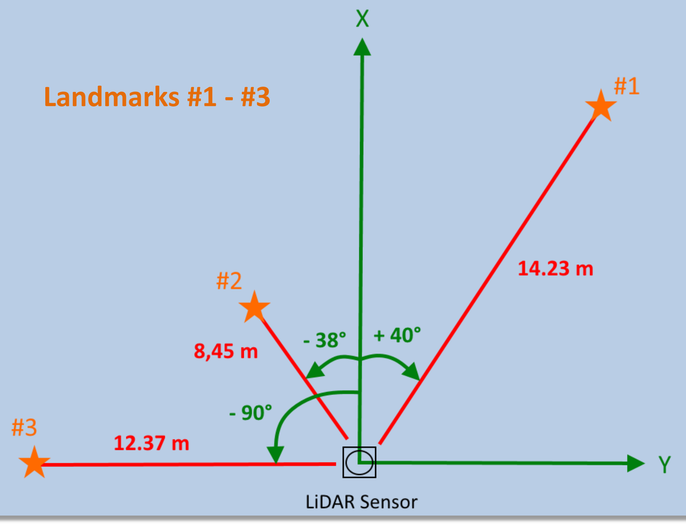
- Range and bearing measurement
- max range: 30 m
- Angular resolution: 0.25°
- FOV: 270°

Position Validation

Differential GPS (**DGPS**)

- Real Time Kinematic (RTK)
- Accuracy < 5 cm
- Attached to local coordinate system of LiDAR in position
- Position reference for Particle Filter

Schematic presentation of range and bearing measurement:

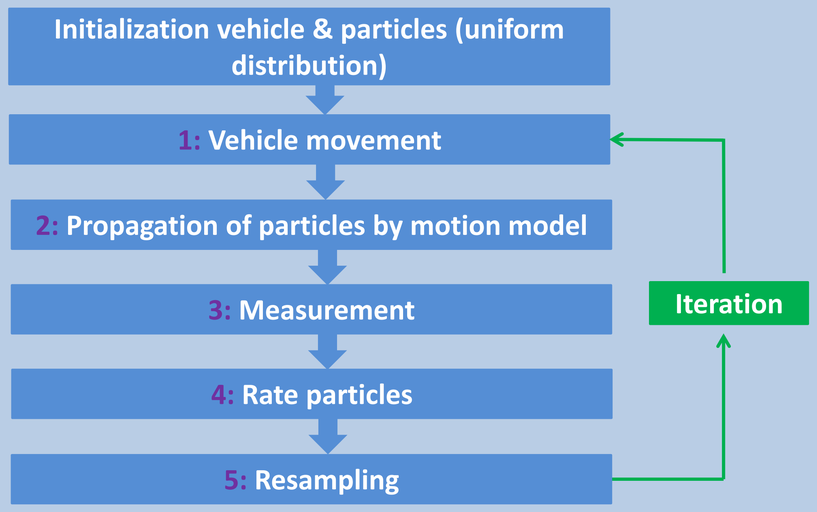


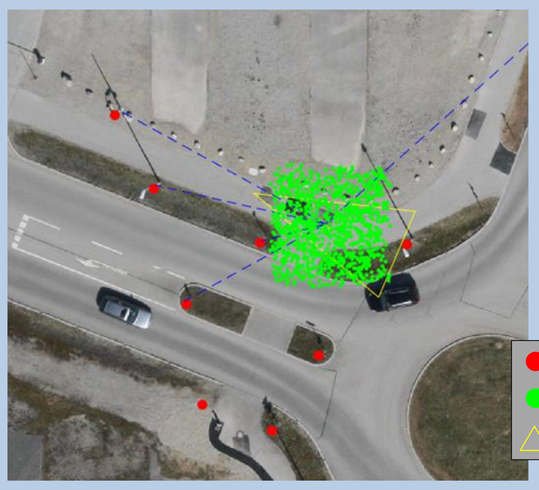
Outlook

- Testing with other sensors (vehicle radar, TOF-Camera)
- Sensor fusion

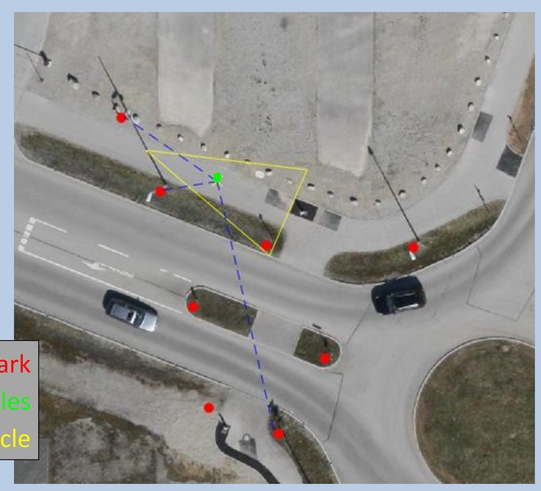
❸ Particle filter-based Landmark-Navigation

- **Probabilistic state estimation** method
- **Global localization** (no initial position in known environment)

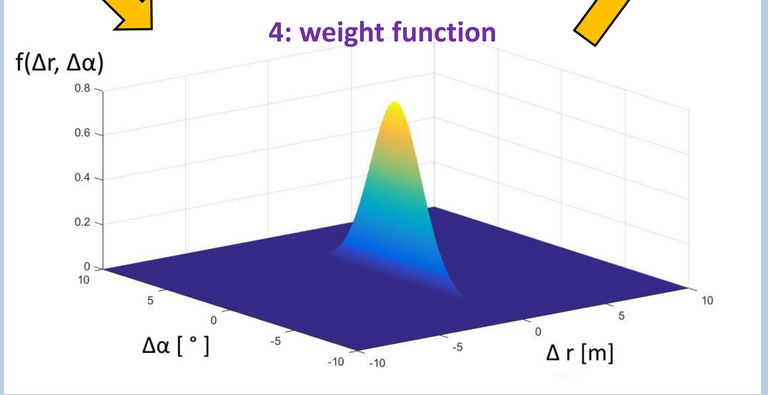




1-3: Initial state with first measurements



5: state after few iteration steps



❹ Results

- Improvement of **position accuracy** with regard to conventional GPS
- Vehicle **position accuracy** (on average):
  - Mean Coordinate deviation: **0.37 m**
  - Standard deviation: **0.04 m**

Comparison of trajectories

Reference

H. Runge, U. Balss, S. Suchandt, R. Klarner, X. Cong: „DriveMark – Generation of High Resolution Road Maps with Radar Satellites", 11th ITS European Congress, Glasgow, Scotland, 2016; Paper number EU-TP0348

H. Runge, U. Balss, S. Suchandt: "Hochgenaue Erfassung der Autobahnen für das automatisierte Fahren, das Projekt DriveMark", Nationales Forum für Fernerkundung und Copernicus, Berlin, Germany, 2015

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Further information

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